dietetics

Review

Mindful Eating Approaches to Cardiometabolic Risk Factors: Systematic Review and Meta-Analysis of Intervention Studies

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Abstract: Mindful eating is the direct application of mindfulness to eating related issues. This approach has been developed to reduce suffering due to food and body image, to improve the capacity to follow the stimuli of hunger and satiety and to minimize the use of food as psychological compensation. The aim of this review is to analyze the results of clinical trials adopting a mindful eating approach to address cardiometabolic risk factors partly related to dysfunctional eating behavior. The selection of literature included articles published until 31 December 2023. The inclusion criteria were controlled randomized clinical trials, an intervention duration ≥4 weeks and indication of a clinical outcome. Fourteen studies were included. The sample sizes ranged from 18 to 194 participants, and the interventions lasted between 4 and 24 weeks. Their effects on body weight, BMI, waist circumference, serum glucose, glycated hemoglobin and C-reactive protein were assessed using a meta-analysis. Mindful eating was as effective as other recognized types of interventions regarding the clinical outcomes examined, but in many cases, they were more effective in terms of factors which may lead to improvement over a longer period. In particular, our analysis showed that mindful eating effectively reduced suffering related to food and body image.

Keywords: mindful eating; mindfulness; weight loss; obesity; overweight; cardiometabolic risk factors

Citation: Iaccarino Idelson, P.; D'Elia, L.; Strazzullo, P. Mindful Eating Approaches to Cardiometabolic Risk Factors: Systematic Review and Meta-Analysis of Intervention Studies. *Dietetics* **2024**, *3*, 271–288. https://doi.org/10.3390/dietetics3030022

Academic Editor: Jose Lara

Received: 1 March 2024
Revised: 11 June 2024
Accepted: 24 June 2024
Published: 1 August 2024

1. Introduction

Mindfulness is a mental state achieved by focusing one's awareness on the present moment and acknowledging and accepting one's thoughts, feelings and bodily sensations without judgment. It is the basic human ability to be fully present without being overly reactive or overwhelmed by environmental conditions; in fact, practicing mindfulness may help to interrupt conditioning patterns, develop emotional balance and well-being and consequently alleviate suffering and cultivate compassion [1].

Since the 1970s, many therapeutic applications based on mindfulness have been developed to help people with a variety of clinical conditions, such as depression and stress [1], drug addiction [2], chronic pain [3] and anxiety [4]. One of the aims of mindfulness is for the individual to take greater responsibility for his or her life choices, resulting in the possibility of clinical conditions related to lifestyle habits being modified. Through a regular mindfulness practice [5], people may learn to heal themselves by observing their own behavior without judgment and subsequently to improve them [6], taking care of their own needs. In fact, people are often aware of the guidelines for a healthy diet but are not able to put them into practice, such as, for example, those for salt consumption [7].

Emerging research suggests that mindfulness-based approaches may have an impact on conditions that are related to dysfunctional food intake and behavior, such as obesity, eating disorders (e.g., bulimia and binge eating) and cardiometabolic disorders. It has been reported that mindfulness practice has a profound effect on brain function by activating the prefrontal cortex and reducing bilateral amygdala activity [8]. These alterations may induce better behavioral regulation and a reduction in emotional eating.

The increasing prevalence of overweight and obesity in recent decades has been accompanied by the increasing prevalence of weight cycling [9] due to unsuccessful dieting. In the United States, dieting and the attempt to lose weight increased from 7 to 40% in men and from 14 to 57% in women from the 1950s to the 2010s [10]. In many cases, these conditions are embodied by suffering; people who try to lose weight through diets and restrictions are accompanied by an inner sense of inadequacy and guilt. People often feel frustrated finding themselves unable to follow the prescriptions given by their doctors, nutritionists or trainers. This frustration can lead to eating more, binging or being more inactive, resulting in feeling even more discouraged. This vicious circle generates a conflictual relationship with food and with the self.

Mindfulness can help reduce suffering in different ways: by reducing stress and anxiety associated with adherence to a prescribed diet and/or exercise, by increasing motivation towards lifestyle changes and by reducing depression due to not being able to reach goals [5].

In particular, mindfulness might help counter weight cycling in the long term and minimize the impact of external drivers of energy intake [11] by reducing anxiety toward food and by improving self-regulation [12].

Mindful eating is the direct application of mindfulness to eating-related issues. Since 2009, various mindful eating protocols have been implemented to work specifically on eating dysregulation conditions [11,13–15]. A few systematic reviews of the effects of mindful eating interventions have been published that focus on specific outcomes, such as food intake, binge eating and weight loss, providing controversial results [16–18]. Often, they have included studies with mindfulness-based interventions lacking a specific focus on mindful eating.

The aim of the present systematic review and meta-analysis is to analyze the results of clinical trials that have adopted a mindful eating protocol or a protocol having a specific mindful eating component in relation to the cardiometabolic conditions featuring a dysfunctional eating behavior.

2. Methods

2.1. Data Sources and Search Strategy

This systematic review and meta-analysis was conducted in accordance with the Cochrane Handbook of Systematic Reviews on Intervention [19] and the PRISMA guidelines [20].

We searched three electronic databases: MEDLINE/PubMed, Embase and Cochrane Central Register of Controlled Trials (CENTRAL) (search last update: 31 December 2023). The search strategy, without restrictions, included the following terms: “mindful eating” OR “mindfulness” AND “eating” OR “eating behavior” OR “eating behaviour”. Moreover, we searched the reference lists of other systematic reviews published on similar topics.

2.2. Eligibility Criteria

The screening was performed by the first author and reviewed by the second author.

The exclusion criteria were the absence of a primary or secondary cardiometabolic outcome, an intervention duration of less than four weeks, the occurrence of outcomes (e.g., behavioral changes) that foreshadowed measurable clinical conditions, the use of a medical therapy that could interfere with the results and the absence of a randomized control trial. There was no age limit on the participants for inclusion in the systematic review, while only studies in adults were included in the meta-analysis. A consensus regarding the eligibility criteria was achieved through discussion among all authors.

2.3. Risk of Bias

The risk of bias in the studies included in the meta-analyses was assessed according to established criteria using the Cochrane Risk of Bias tool I [19].

2.4. Data Extraction

We developed an electronic spreadsheet to extract the following categories from the full text of each included study: the available data on the study identification, target

population, study sample, age, sex, primary outcomes, secondary outcomes, intervention duration, weeks of follow-up; a brief description of the intervention (including number of participants and % women); a description of the mindful eating component; a brief description of the control group (including number of participants and % women); essential results. The data extraction was conducted in April 2023 and revised in December 2023. When two different articles reported results on the same study in the same population, we referred only to the most recent one.

2.5. Data Analysis

The analyses concerned body weight, BMI, waist circumference, serum glucose, glycated hemoglobin and C-reactive protein, since adequate data were available for these outcomes. The weighted mean differences (WMDs) and standard error of the mean (SEM) of the defined outcomes were extracted from the selected publications. If these were not available, the WMDs and SEM were calculated from a comparison of the outcomes of the different interventions. The pooled WMDs and 95% confidence intervals (CIs) were estimated using a random-effect model [21]. The Cochrane Q test and the I2 statistic were used to evaluate the statistical heterogeneity across the studies. Funnel plots were constructed and visually assessed for possible publication bias. The statistical analyses were performed using the StataCorp software (version 11.2; College Station, TX, USA).

3. Results

3.1. Study Selection

After the initial database search and having removed duplicates, we retrieved 689 papers by title and abstract. We selected 94 articles relevant to the topic of our study for full-text screening and then included 3 more from the references, comprising a total of 97 articles. Eighty-three papers were excluded after reading their full text, based on the exclusion criteria (no clinical outcomes, studies describing the protocol but not the intervention, use of medications, intervention < four weeks, no mindful eating component included in the intervention, no control group). Ultimately, 14 studies were included in our systematic review (Figure 1).

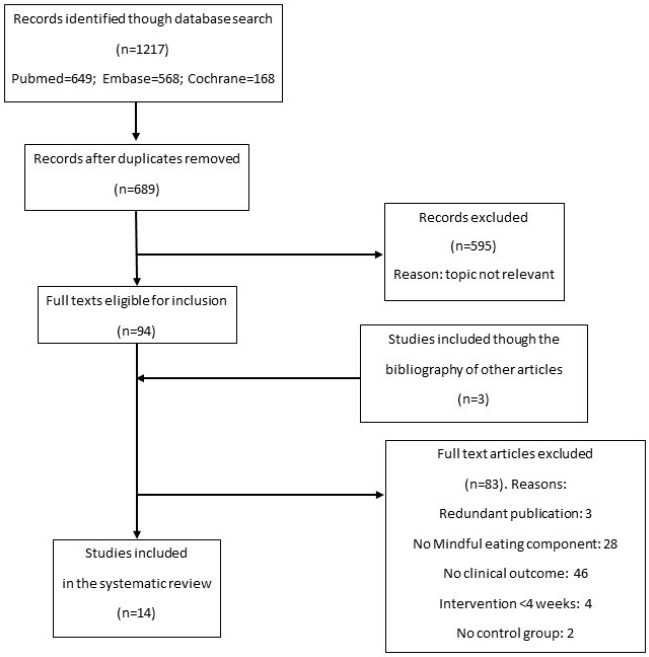

Figure 1. Flowchart of the study selection process.

3.2. Characteristics of the Studies

A description of the studies included in the systematic review is given in Table 1 [13–15,22–33].

Table 1. Main features and results of the studies included in the systematic review.

Author (Year), Study Design, Country	Study Population Age (Years)	Primary Outcomes	Secondary Outcomes	INT and Follow-Up Duration (Weeks)	Short Description of INT N. of Participants (% Female)	Short Description of CG N. of Participants (% Female)	Main Results
Carpenter, 2019 [22] RCT USA	69 OB adults Age: 47.3 ± 2.4	Feasibility and acceptability of ME program	WL, Improvement in the approach towards food	INT = 24 Follow-up = 0	Mind your Weight (MYW): 11 phone calls with mindfulness and ME practices 46 (92%)	Weight Talk: 11 phone calls with counselling based on NIH guidelines + unlimited support phone calls. 23 (92%)	• Similar feasibility and acceptability of MEI and CONTROL (Fisher's $p = 1$). • Both MEI and CONTROL groups lost about 3% of the baseline weight ($p = 0.68$). • Significant improvement in all indicators of a conscious approach towards food in MEI vs. CONTROL ($p < 0.05$). • Improvement in MEI significantly associated with higher % WL ($p = 0.03$). • Significant binge eating sub-factor improvement in MEI vs. CONTROL ($p < 0.001$).
Chacko, 2016 [23] RCT USA	18 OB adults 1–5 years post-bariatric surgery Age: 53.9 ± 6.7	Weight gain prevention and improvements in eating behavior, psychosocial factors, HbA1c, adiponectin, hs-CRP, IL-6, TNF-α		INT = 10 Follow-up = 24	Mindfulness-Based Intervention (MBI): 10 × 90 min group sessions based on mindfulness (MBSR) and ME (MB-EAT) + ½ day of meditation practice + homework assignment 9 (90%)	Standard care: 1 × 1 h session with a dietitian on nutrition and physical activity guidelines and on strategies to prevent weight gain and improve lifestyle. 9 (78%)	• 1 kg weight gain in MEI and 0.1 kg WL in CONTROL ($p = 0.27$). • Significant reduction in emotional hunger in MEI vs. CONTROL at 6 months ($p = 0.03$). • Stress reduction in both MEI and CONTROL at 12 months ($p = 0.05$). • No significant change in biochemical parameters, except for HbA1c (+0.34 in MEI vs. −0.06 in CONTROL ($p = 0.03$)).

Table 1. *Cont.*

Author (Year), Study Design, Country	Study Population Age (Years)	Primary Outcomes	Secondary Outcomes	INT and Follow-Up Duration (Weeks)	Short Description of INT N. of Participants (% Female)	Short Description of CG N. of Participants (% Female)	Main Results
Daly, 2016 [15] RCT USA	23 OB female adolescents Age: 15.4 ± 1.4	BMI reduction, mindfulness improvement		INT = 6 Follow-up = 10	Mindful Eating Intervention (MEI): 6 × 90 min group sessions ME, behavioral skills, motivational inputs and information on nutrition and PA 8 (100%)	Standard care: One visit with prescription of diet and PA. 15 (100%)	At 6 weeks: • Significant BMI reduction in MEI vs. CONTROL (−1.1 vs. +1.5 kg/m^2, $p = 0.001$). • No mindfulness improvement (neither for MEI vs. CONTROL nor for post- vs. pre-MEI).
Daubenmier, 2016 [24] RCT USA	194 OB adults Age: 47 ± 13	WL maintenance at 18 months	Reduction in WC, GLU, TRIG, HDL, LDL, HOMA-IR, HbA1c, hs-CRP, BP	INT = 22 Follow-up = 72	16 × 2.5 h sessions (12 weekly + 3 bimonthly + 1 monthly + 1 × 6.5 h session) with GL on nutrition, PA + training based on mindfulness (MBSR and MBCT) and ME (MB-EAT) 100 (79%)	Same protocol, replacing mindfulness and ME with nutrition and PA information, strength training and weight loss discussions. 94 (86%)	• WL in both MEI (−5.1 kg) and CONTROL (−3 kg) at 12 months ($p = 0.06$). • WL in both MEI (−5 kg) and CONTROL (−3.2 kg) at 18 months ($p = 0.2$). • Significant reduction (for MEI vs. CONTROL) at 12 months in GLU ($p = 0.02$), TRIG/HDL ratio ($p = 0.03$), LDL ($p = 0.04$) and TRIG at 6 months ($p = 0.03$). • Reduction in weight, WC, HOMA, HbA1c and hs-CRP in both MEI and CONTROL ($p > 0.05$). • LDL reduction and HDL improvement in both MEI and CONTROL at all time points ($p > 0.05$).

Table 1. *Cont.*

Author (Year), Study Design, Country	Study Population Age (Years)	Primary Outcomes	Secondary Outcomes	INT and Follow-Up Duration (Weeks)	Short Description of INT N. of Participants (% Female)	Short Description of CG N. of Participants (% Female)	Main Results
Kristeller, 2014 [14] RCT USA	92 adults with BED Age: 46.6	Reduction in frequency and dimensions of binge episodes	BMI reduction	INT = 12 Follow-up = 28	Mindfulness-Based Eating Awareness Training (MB-EAT): 9 × 2 h weekly group sessions + 3 monthly sessions based on mindfulness meditations, ME practices, awareness exercises on physical and emotional hunger and on satiety and homework 39 (82%)	1. Psycho-educational program: Same structure of the intervention but replacing mindfulness with behavioral therapy. 27 (82%) 2. Waiting list: No treatment, but re-contact after 3 months. 26 (82%)	• Slightly higher reduction in frequency and dimensions of binge episodes in MEI vs. CONTROL ($p = 0.05$). • Small BMI reduction (2 kg) in both MEI and CONTROL ($p > 0.05$). • More meditation practice was related to greater weight loss in MEI ($p < 0.05$).
Mason, 2016 [25] RCT USA	194 OB adults Age: 47 ± 13	Reduction in the use of food as compensation and in psychological stress	WL	INT = 22 Follow-up = 72	5.5-month program based on ME (MB-EAT) and nutrition and PA guidelines (12 × 2.5 h weekly group sessions + 3 bi-monthly + 1 × 6.5 h session) 100 (79%)	Same protocol, replacing mindfulness and ME with nutrition and PA information, muscle relaxation and weight loss discussions. 94 (86%)	• Significant reduction in the use of food as psychological compensation at 6 months in MEI vs. CONTROL ($p = 0.03$), which indirectly affected weight loss at 12 months ($p = 0.03$). • WL in both MEI and CONTROL ($p = 0.08$).

Table 1. *Cont.*

Author (Year), Study Design, Country	Study Population Age (Years)	Primary Outcomes	Secondary Outcomes	INT and Follow-Up Duration (Weeks)	Short Description of INT N. of Participants (% Female)	Short Description of CG N. of Participants (% Female)	Main Results
Mason, 2016 [26] RCT USA	194 OB adults Age: 47 ± 13	Reduction in sweet consumption and in basal blood glucose at 6 months	Maintenance of results after 12 months, improvement of a more conscious approach towards sweet consumption	INT = 22 Follow-up = 48	5.5-month program based on MB-EAT and nutrition and PA guidelines (12 × 2.5 h weekly group sessions + 3 bimonthly + 1 × 6.5 h session) 100 (79%)	Same protocol, replacing mindfulness and ME with nutrition and PA information, muscle relaxation and weight loss discussions. 94 (86%)	At 6 and 12 months: • Increased sweet consumption and blood glucose in CONTROL (p = 0.0.35). At 12 months: • Significant improvement of a conscious approach towards food in MEI vs. CONTROL (p = 0.036) • Reduction in sweet consumption and GLU in both MEI and CONTROL at 6 months (p = 0.06).
Miller, 2012 [27] RCT USA	52 OV diabetic adults Age: 54 ± 8	Weight loss, BMI reduction	Reduction in WC, HA1c, basal blood glucose, insulin	INT = 12 Follow-up = 24	MB-EAT-D: 10 × 2.5 h weekly group session + 1 monthly session on ME (MB-EAT) adapted to diabetes 27 (63%)	Smart choices (DSME): Same structure, replacing ME with standard information protocol on diabetes. 25 (64%)	• In both MEI and CONTROL, reduction in weight (p = 0.07), BMI (0.07), WC (p = 0.05), HbA1c (p = 0.6), GLU (p = 0.4), insulin (p = 0.2). At 3 and 6 months: • Reduction in food intake and glycemic index and increased fiber consumption in both MEI and CONTROL. Differences between groups not evaluated.

Table 1. *Cont.*

Author (Year), Study Design, Country	Study Population Age (Years)	Primary Outcomes	Secondary Outcomes	INT and Follow-Up Duration (Weeks)	Short Description of INT N. of Participants (% Female)	Short Description of CG N. of Participants (% Female)	Main Results
Palmeira, 2017 [28] RCT Portugal	73 OV/OB women Age: 42.0 ± 8.5	Improved quality of life, reduction in weight-related stigma and binge and emotional eating	Reduction in BMI, WC, tot. CHOL and general health and PA improvement	INT = 14 Follow-up = 10	Kg-free: Standard treatment + 10 × 2.5 h weekly group sessions + 2 sessions every 2 months with meditation, mindfulness and ME practices, self-compassion and kindness + psycho-educational interventions 36 (100%)	Standard treatment: Visits with medical doctors and nutritionists, giving personalized dietetic recommendations + PA prescriptions. 37 (100%)	• Greater improvement in weight self-stigma, quality of life, emotional eating and uncontrolled eating in MEI vs. CONTROL ($p \leq 0.027$). • Significant BMI reduction in MEI vs. CONTROL ($p = 0.02$). • Nonsignificant WC ($p = 0.3$) and CHOL ($p = 0.6$) reduction in MEI. • Significant improvement in PA and health perception in MEI vs. CONTROL ($p < 0.001$).
Radin, 2023 [29] RCT USA	161 OV/OB participants with mild/ moderate stress Age: 38 ± 11	Perceived stress, tolerance for food cravings	Reduction in BMI, WC and binge eating	INT = 8 Follow-up = 0	Meditation (MED): Participants were provided with a digital meditation app and invited to use it at least for 10 min/day 38 (71%) Meditation + Healthy eating (MED + HE) 40 (68%)	Healthy eating (HE): 1 × 50 min nutritional counselling session + 3 booster phone calls + invitation to follow a digital mindful eating program once/week × 8 weeks with audio exercises inspired by MB-EAT. 41 (83%) Waiting list 42 (67%)	• Greater reduction in perceived stress score in MEI vs. CONTROL ($p < 0.001$), with no difference between the two MEI ($p = 0.3$) and the two CONTROLS ($p = 0.8$). • Tolerance for food cravings did not differ among the four groups, with a slightly better acceptance in CONTROLS vs. MEI. • WC slight reduction in MEI, with slight WC increase in CONTROLS ($p = 0.03$). • Treatment adherence was associated with a greater decrease in WC ($p < 0.001$). • BMI slightly decreased in MED + HE, while it slightly increased in all other groups. • Slight reduction in BMI in MEI vs. CONTROLS ($p = 0.29$).

Table 1. *Cont.*

Author (Year), Study Design, Country	Study Population Age (Years)	Primary Outcomes	Secondary Outcomes	INT and Follow-Up Duration (Weeks)	Short Description of INT N. of Participants (% Female)	Short Description of CG N. of Participants (% Female)	Main Results
Salvo, 2022 [30] RCT Brasil	133 OW/OB women Age: 40.4 ± 10.7	Improvement of eating behavior	Biochemical control (GLU, TRIG, HbA1c, insulin, tot. CHOL, HDL, LDL, serum cortisol and hs-CRP), body composition improvement, weight and WC reduction	INT = 10 Follow-up = 12	MB-EAT-SP (MB-EAT adapted to Sao Paulo population) 10 weekly group sessions on mindful meditation, ME practices, awareness of satiety and hunger, homework and greater acceptance regarding eating and weight 45 (100%) Mindfulness-based health promotion (MBHP) + TAU: 10 weekly group sessions based on mindful meditations, mini-meditations, walking meditations and homework 40 (100%)	Treatment as usual (TAU): According to OV/OB rate and of presence of co-morbidities, different actions were planned: from a care plan to achieve a normal BMI range to a dietary prescription and/or behavioral or pharmaco-therapy. 48 (100%)	• Significant reduction in BE in MB-EAT-SP vs. MBHP and TAU ($p < 0.001$). • In both MEI groups, slight weight reduction ($p = 01.62$) and WC reduction ($p = 0.429$) vs. CONTROL. • Slight increase in lean mass in MB-EAT-SP vs. MBHP and TAU ($p = 0.058$). • No changes in biochemical parameters.
Smith, 2018 [31] RCT USA	36 Post-menopausal OB women Age: 58.5 ± 4.5	Reduction in BMI, WHR, IL-6, hs-CRP	BED reduction	INT = 6 Follow-up = 48	MEAL: 6 × 2 h weekly group sessions based on ME(MB-EAT) 18 (100%)	Active control: 6 × 2 h weekly group sessions based on nutritional counselling, goal setting and group support. 18 (100%)	• No significant reduction in WL ($p = 0.6$), BMI ($p = 0.5$) WHR ($p = 0.2$) or BE ($p = 0.07$) in either MEI or CONTROL. • Significant IL-6 and hs-CRP reduction in MEI vs. CONTROL ($p = 0.006$).

Table 1. *Cont.*

Author (Year), Study Design, Country	Study Population Age (Years)	Primary Outcomes	Secondary Outcomes	INT and Follow-Up Duration (Weeks)	Short Description of INT N. of Participants (% Female)	Short Description of CG N. of Participants (% Female)	Main Results
Spadaro, 2017 [32] RCT USA	46 OV/OB adults Age: 45.2 ± 8.2	Weight loss	Caloric intake reduction, improvement in eating behaviors PA and mindfulness	INT = 24 Follow-up = 0	Standard behavioral WL program + mindfulness and ME: weekly group session for 6 months on nutrition, PA, behavioral changes + 30 min ME practices 22 (90.9%)	Standard behavioral weight loss program, with the same structure as MEI but without mindfulness and ME. 24 (83.3%)	• Significant WL by time interaction (p = 0.03). • No significant caloric intake reduction (p = 0.8) or PA improvement (p = 0.3) in MEI vs. CONTROL. • Significant improvement in eating behaviors and food control in MEI vs. CONTROL (p = 0.02).
Youngwanichesetha, 2014 [33] RCT Thailand	170 women with G-diab Age: 31 ± 5	Reduction in basal GLU, post-prandial GLU and HbA1c		INT = 8 Follow-up = 0	Standard diabetes care + 2 × 50 min yoga and ME + encouragement to practice 5 days/week × 8 weeks 85 (100%)	Standard diabetes care 85 (100%)	• Significant reduction in basal GLU (p = 0.012), post-prandial GLU (p = 0.001) and HbA1c (p = 0.016) in MEI vs. CONTROL.

BE = binge eating; BED = binge eating disorder; BMI = body mass index; BP = blood pressure; CG = control group; CHOL = cholesterol; G-diab = gestational diabetes; GLU = glucose; HDL = high-density lipoprotein; hbA1C = glycated hemoglobin; HOMA-IR = homeostasis model assessment for insulin resistance; hs-CRP = high-sensitivity C-reactive protein; IL-6 = interleukin-6; INT = intervention; LDL = low-density lipoprotein; MBCT = mindfulness-based cognitive therapy; MBSR = mindfulness-based stress reduction; ME: mindful eating; MEI: mindful eating intervention; NIH = National Institute of Health; OB = obese; OV = overweight; PA = physical activity; TRIG = triglycerides; WC = waist circumference; WHR = waist–hip ratio; WL = weight loss.

All the articles were published between 2012 and 2023. Eleven studies were conducted in the USA [1,15,22–27,29,32,33], one in Portugal [28], one in Thailand [33] and one in Brazil [30]. The sample size ranged from 18 to 194. The participants were mostly female (from 63% to 100% women in the different studies). The studies were conducted mainly among adults (with the exception of one study conducted on adolescents), with a mean age ranging from 21.4 to 58.5 years. The intervention lasted between 4 and 24 weeks. The target population consisted of overweight/obese patients in 11 studies [15,16,23–31], diabetic patients in 2 studies [27,33] and patients with an eating disorder diagnosis in 1 study [14]. As for the characteristics of the control groups, five studies compared a mindful eating intervention with standard-care treatment [15,23,28,32,33]; in two studies, the population which received a mindful eating intervention was checked against a population on a waiting list or in another program [14,29]; seven studies compared a mindful eating intervention with an intervention of the same structure but replacing mindful eating with other methodological instruments [22,24–27,31,32]. Moreover, six were based on a structured mindful eating protocol [14,22,27,30,31], whereas all the others had at least one mindful eating component in their intervention program.

3.3. Risk of Bias

The evaluation of the "risk of bias" indicated that the studies were substantially at low risk (Supplemental Table S1), but only one study reported a low risk of bias for all of the criteria defined a priori. The allocation concealment was unclear in one study and also in the blinding process for the majority of the studies. Moreover, the characteristics of the participants allocated into the intervention and control groups were different at baseline in two studies, and this led to high risk of other bias.

3.4. Effect on Body Weight

The effect of the intervention on body weight was assessed in 12 studies. In six of the studies, weight loss was the primary outcome, and in five, it was a secondary outcome, whereas one study focused on weight gain prevention in obese patients post-bariatric surgery. In the studies where weight loss was among the primary outcomes, the reduction was statistically significant in two studies, while in three studies, there was a comparable weight reduction in the intervention and control groups, and in one study, the intervention was associated with slight weight gain. In all the studies in which weight reduction was among the secondary outcomes, the result was similar in the two study arms, except for Palmeira's study [29], in which the weight reduction was significantly greater in the intervention compared with the control group.

The meta-analysis of the effect of a mindful eating intervention on body weight included seven RCTs with 673 total participants [23–25,27,30–32] (Figure 2). One month, three months and six months of intervention were not associated with significant differences in body weight changes in the mindful eating intervention vs. the control group (one month, WMD: +1.46 kg, 95% CI: −0.10 to 3.02; $p = 0.07$; three months, WMD: +0.01 kg, 95% CI: −1.29 to 1.32; $p = 0.98$; six months, WMD: −0.26 kg, 95% CI: −2.00 to 1.48; $p = 0.77$), whereas a pooled analysis of the effects of a mindful eating intervention at one year showed a significant reduction in body weight in comparison with the control intervention (WMD: −1.92 kg, 95% CI: −3.83 to −0.02; $p = 0.048$). At 18 months of the intervention, a lower body weight was maintained in patients receiving a mindful eating intervention, but the difference from the control group was not significant (WMD: −1.45 kg, 95% CI: −3.71 to 0.80; $p = 0.21$).

There was no significant heterogeneity among studies with different-length interventions (I2: 0–44%, $p > 0.10$). Visual analysis of the funnel plots indicated no asymmetry (Supplemental Figure S1).

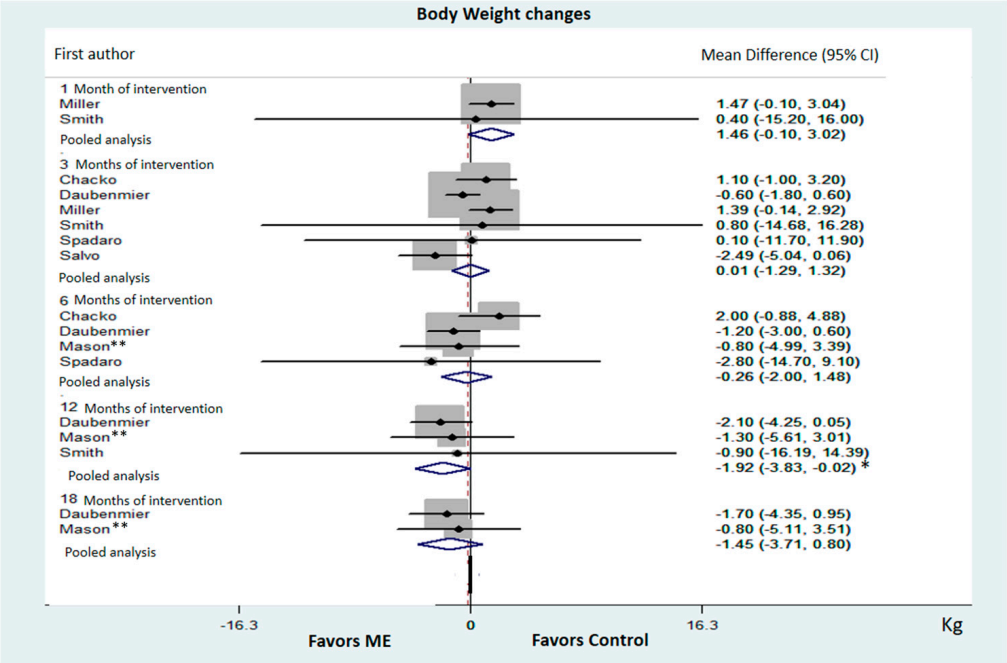

Figure 2. Forest plot of the effect of mindful eating on body weight changes. Results are expressed as mean difference and 95% confidence intervals (95% CIs). * $p < 0.05$; ** ref. [25].

With regard to BMI, the meta-analysis of the effects of ME on BMI included seven RCTs and 478 male and female participants [14,23,27–29,31,32]. BMI was not significantly changed after one, three–four or six–nine months of a mindful eating intervention compared to the control interventions (one–two months, WMD: −0.04 kg/m^2, 95% CI: −0.97 to 0.89, $p = 0.93$; three–four months, WMD: +0.36 kg/m^2, 95% CI: −0.08 to 0.80; $p = 0.11$; six–nine months, WMD: −0.24 kg/m^2, 95% CI: −0.65 to 0.18; $p = 0.26$). For any length of intervention, there was no significant heterogeneity among studies (I2: 0–49%, $p > 0.2$) and no evidence of publication bias according to visual analysis of the funnel plots (Supplemental Figure S2).

Table 2 shows the changes in body weight (or BMI) in all the studies included in the systematic review. A body weight reduction was observed in almost all studies, with a statistically significant difference between the mindful eating interventions and the interventions used in the control groups observed in three studies [15,28,32].

Table 2. Analysis of weight change in the studies included in the systematic review.

Author	Mean Body Weight (kg) ± SD or BMI Change (kg/m^2) in MEI Group	Mean Body Weight (kg) ± SD or BMI Change (kg/m^2) in Control Group	*p*
Carpenter, 2019 [22]	At 6 months: −2.4 ± 4.4 kg	At 6 months: −2.6 ± 3.2 kg	0.68
Chacro, 2016 [23]	At 3 months: +1.0 ± 1.76 kg At 6 months: +2.3 ± 3.5 kg	At 3 months: −0.1 ± 2.4 kg At 6 months: +0.3 ± 2.1 kg	0.27 0.15
Daly, 2016 [15]	At 1.5 months: −1.1 kg/m^2 At 2.5 months: −1.4 kg/m^2	At 1.5 months: +0.72 kg/m^2 -	0.001
Daubenmier, 2016 [24]	At 3 months: −3.9 ± 0.4 kg At 6 months: −5.2 ± 0.6 kg At 12 months: −5.1 ± 0.8 kg At 18 months: −5.0 ± 0.9 kg	At 3 months: −3.3 ± 0.4 kg At 6 months: −4.0 ± 0.7 kg At 12 months: −3.0 ± 0.8 kg At 18 months: −3.2 ± 1.0 kg	0.34 0.19 0.06 0.2
Kristeller, 2014 [14]	At 1 month: −0.1 kg/m^2 At 4 months: +0.5 kg/m^2	At 1 month: −0.5 kg/m^2 At 4 months: −0.02 kg/m^2	>0.05 >0.05

Table 2. *Cont.*

Author	Mean Body Weight (kg) ± SD or BMI Change (kg/m^2) in MEI Group	Mean Body Weight (kg) ± SD or BMI Change (kg/m^2) in Control Group	*p*
Mason, 2016 [25]	At 6 months: −5.6 kg At 12 months: −5.46 kg At 18 months: −5.2 kg	At 6 months: −4.8 kg At 12 months: −4.16 kg At 18 months: −4.35 kg	>0.05 >0.05 >0.05
Miller, 2012 [27]	At 3 months: −1.78 kg At 6 months: −1.53 kg	At 3 months: −3.25 kg At 6 months: −2.92 kg	>0.05 >0.05
Palmeira, 2017 [28]	At 6 months: −0.54 ± 0.92 kg/m^2	At 6 months: −0.07 ± 0.76 kg/m^2	0.022
Radin, 2023 [29]	At 2 months: −0.66 kg/m^2	At 2 months: +0.06 kg/m^2	0.29
Smith, 2018 [31]	At 1.5 months: −3.25 kg At 4 months: −4.41 kg At 9 months: −6.09 kg At 12 months: 7.26 kg	At 1.5 months: −3.62 kg At 4 months: −5.2 kg At 9 months: −6.62 kg At 12 months: −6.31 kg	>0.05 >0.05 >0.05 >0.05
Spadaro, 2017 [32]	At 3 months: −5 kg At 6 months: −6.9 kg	At 3 months: −5.1 kg At 6 months: −4.1 kg	>0.05 0.03

MEI = mindful eating intervention.

3.5. Effect on Waist Circumference

A reduction in waist circumference was a secondary outcome in five studies, and its reduction was greater in the ME intervention group compared to the control group in two studies ([27] $p = 0.05$, and [29] $p = 0.03$).

The meta-analysis of the effect of a mindful eating intervention on waist circumference included five RCTs and 470 total participants [23,24,27,28,30] (Figure 3). After three months and six months of mindful eating interventions, there were no significant changes in waist circumference (three months, WMD: +0.49 cm, 95% CI: −1.11 to 2.09; $p = 0.54$; six months, WMD: −0.78 cm, 95% CI: −2.18 to 0.63; $p = 0.28$). There was low–moderate heterogeneity among studies (I2: 0–35%, $p > 0.2$). Visual analysis of the funnel plots indicated no asymmetry (Supplemental Figure S3).

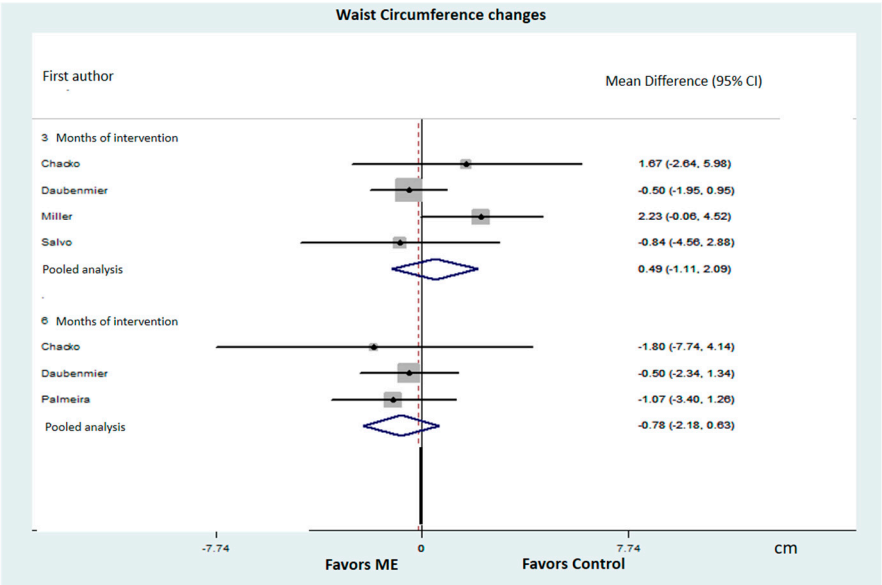

Figure 3. Forest plot of the effect of mindful eating on waist circumference changes. Results are expressed as mean difference and 95% confidence intervals (95% CIs).

3.6. Effect on Serum Glucose

Five studies analyzed the changes in serum glucose upon a mindful eating intervention, with two implementing this as a primary outcome and three as a secondary one. A trend toward glucose reduction was observed in four studies, with a significant difference in two of them [24], $p = 0.02$, and [34], $p = 0.01$).

The meta-analysis of the effect of mindful eating interventions on serum glucose included four RCTs and 573 total participants [24,26,27,30] (Figure 4). The analysis showed a reduction in serum glucose starting from six months of the mindful eating intervention compared with the control (three months, WMD: +7.01 mg/dL, 95% CI: −6.65 to 20.66; $p = 0.31$; six months, WMD: −0.83 mg/dL, 95% CI: −2.75 to 1.09, $p = 0.39$; 12 months, WMD: −2.70 mg/dL, 95% CI: −4.39 to −1.00, $p = 0.002$). Only in the analysis of a three-month intervention was there significant heterogeneity among studies (I2: 80%, $p = 0.01$) and evidence of publication bias according to visual analysis of the funnel plots (Supplemental Figure S4).

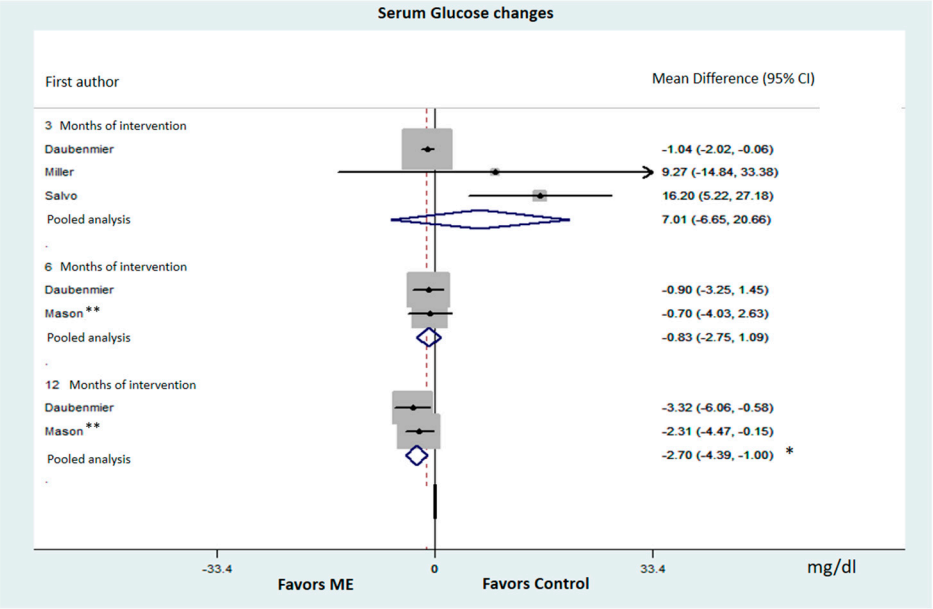

Figure 4. Forest plot of the effect of mindful eating on blood glucose changes. Results are expressed as mean difference and 95% confidence intervals (95% CI). * $p < 0.05$; ** ref. [26].

3.7. Effect on Glycated Hemoglobin

Glycated hemoglobin changes were analyzed in five studies (one in diabetic patients as a secondary outcome [27], one in obese adults post-bariatric surgery [23], one in a group of women with gestational diabetes as the primary outcome [34] and two in OV/OB adults as the secondary outcome [24,30]).

No significant difference was observed in the HbA1C reduction between the mindful eating interventions and the control groups in any of the studies, except for that by Youngwanichsetha et al. [33], who found a significantly greater HbA1C reduction in the women with gestational diabetes undergoing the mindful eating intervention vs. the control group ($p = 0.016$).

The meta-analysis of the effect of mindful eating intervention on glycated hemoglobin included four RCTs and 397 total participants [23,24,27,30]. There was no apparent effect of mindful eating interventions on glycated hemoglobin, either at three or six months of the intervention (three months, WMD: +0.04%, 95% CI: −0.06 to 0.14, $p = 0.43$; six months, WMD: +0.15%, 95% CI: −0.28 to 0.57; $p = 0.50$). Only in the analysis at 6 months into the intervention was there significant heterogeneity among studies (I2: 82%, $p = 0.02$) and visual analysis of the funnel plot indicative of asymmetry (Supplemental Figure S5).

3.8. Effect on C-Reactive Protein

The effect of mindful eating interventions on CRP levels was investigated in three studies; only in one was it a primary outcome [23]. Smith [32], in a RCT of 36 post-menopausal OB women, detected a significant reduction in the mindful eating intervention compared to the control group ($p = 0.006$). In the other studies, the CRP reduction was not significantly greater when using ME interventions compared with other treatments.

The meta-analysis of the effect of ME interventions on CRP levels included four studies and 381 participants [23,24,30,31]. Mindful eating interventions were associated with a non-significant trend toward a reduction in CRP levels, both at three–four and six months (3/4 months, WMD: −0.79 mg/l, 95% CI: −1.79 to 0.22, $p = 0.12$; six months, WMD: −0.46 mg/l, 95% CI: −1.22 to 0.30, $p = 0.24$). There was no significant heterogeneity among studies (I2: 0%, $p > 0.40$) and no evidence of publication bias according to visual inspection of the funnel plots (Supplemental Figure S6).

3.9. Effect on Psychological and Behavioral Aspects

Several psychological changes were associated with the mindful eating interventions, which, in turn, may be supportive of changes in clinical conditions. Statistically significant reductions were observed in the following factors: binge eating disorder (BED) symptoms in three studies (p between 0.003 and 0.001) [14,22,30], including the frequency and dimensions of binge eating episodes ($p = 0.005$) [14]; emotional eating at 10 weeks ($p < 0.027$) [28] and at six-month follow-up ($p = 0.003$) [23]; the use of food as psychological compensation [22]; weight stigma and uncontrolled eating [28]. Moreover, significant improvements were reported in eating behaviors and food control [32] and in quality of life, physical activity and health perception [28]. Finally, significant stress and anxiety reductions were observed in two mindful eating intervention studies [23,29].

4. Discussion

This is, to our knowledge, the first study which comprehensively reviews the effects of mindful eating interventions on cardiometabolic risk factors. It showed that mindful eating programs are at least as effective as traditional interventions in terms of the anthropometric and metabolic variables investigated. A statistically significant benefit was shown for body weight and serum glucose levels, with a trend of waist circumference and glycated hemoglobin also decreasing. This is in accordance with the results of previous meta-analyses, which, however, focused their interest almost exclusively on weight loss [16,34,35]. We believe that analyzing a larger set of clinical outcomes is useful to understand where to better target further research in this area.

Interestingly, significant reductions in both body weight and blood glucose were observed with mindful eating interventions in comparison to other interventions after 12 months of follow-up. This is likely because mindful eating is an approach which helps patients "get in touch" with one's physical sensations of hunger and satiety, as well as with one's emotions and their link to food behaviors, without depending on a strict dietary prescription. The prescription of a diet may be more effective in the short term but less effective in the long term because adherence to a prescribed diet implies a disconnection from (instead of a connection with) our physical needs and our own body wisdom [13]. Moreover, dietary rules often lead to food obsession and eating disorders [36].

It is well known that obesity, binge eating and related disorders not only cause measurable clinical outcomes but may be associated with unproductive suffering in people who struggle with food and/or with their body image. These people very often live in a vicious circle of anxiety–eating–feeling guilty–eating. Our systematic review of the literature showed that mindfulness is effective in reducing anxiety and improving a healthier approach to both life and eating. This improvement was significantly associated with a higher weight reduction [15,22]. In particular, more time spent in meditation practice was associated with a greater weight loss in the MB-EAT protocol [14]. Anxiety is only one of the emotions which drives eating and/or binge eating. Emotional hunger often affects obese

people and binge-eaters. Chacko et al. [23] observed a significant reduction in emotional hunger after a 10-week mindful eating program compared to the standard care in 18 obese adults post-bariatric surgery ($p < 0.03$). Likewise, Mason et al. [25] found a significant reduction in the use of food as psychological compensation after a mindful eating intervention, comparing it to a traditional intervention with a similar structure but without mindful eating components. The same results were reported by Palmeira et al. [28], examining a population of 73 overweight/obese women. BED is a psychopathological condition characterized by poor self-esteem, strong dysregulation of appetite and satiety, extremely poor oral control and the frequent use of food to handle emotional distress [14]. Among the various current treatments for binge eating, mindfulness and mindful eating can be seen as a cost-effective option. In fact, a mindful eating group protocol (MB-EAT) developed by Kristeller et al. [14] showed a slightly higher reduction in BED symptoms (in terms of both frequency and dimensions) than a psycho-educational group, while Smith et al. [31] found a significant reduction in BED symptoms in both the mindful eating intervention and the active control (nutritional counselling group sessions), and Spadaro et al. [32] observed a significant improvement in eating behaviors and food control just by adding 30 min MB-EAT practices to the same 6-month behavioral standard weight loss program.

Finally, when analyzing only the studies comparing a mindful eating intervention to one with the same structure but replacing mindfulness and mindful eating with other methodological tools, significant improvements were observed with mindful eating interventions in terms of the following indicators: a conscious approach towards food, the use of food as psychological compensation and eating behavior and food control. Time spent in meditation practices and improvement of a mindful eating approach were associated with a higher percent weight loss.

5. Strengths and Limitations

The strengths of our systematic review are the strict pre-defined inclusion criteria and the broad search terms used in order to retrieve as many of the published studies on the subject as possible. Moreover, we included all cardiometabolic outcomes in the same review, a feature potentially leading, in our opinion, to a better understanding of the possibilities of mindful eating.

There are also limitations to our work. First is the scarcity of studies analyzing clinical outcomes. This may be due to the nature of mindful eating interventions, whose primary goal is not just weight loss nor the improvement of cardiometabolic conditions but rather a reduction in suffering related to food, the improvement of quality of life, connection with inner bodily wisdom and a reduction in self-stigma. All of these factors are related, but only indirectly to weight loss and weight maintenance. Another limitation is that the studies covered in this review included mainly women. Therefore, we cannot generalize our results to both sexes. Finally, the average duration of the interventions and follow-up periods is relatively short and not sufficient to enable conclusions over a long-term period. This is quite common in studies on behavior improvements and weight loss, but undoubtedly further research is needed to evaluate the efficacy of long-term mindful eating interventions.

6. Conclusions

This systematic review and meta-analysis highlights the beneficial effect of mindful eating interventions both on cardiometabolic outcomes and on other factors that can indirectly lead to an improvement in clinical conditions. In particular, mindful eating interventions appear to contribute to reducing suffering related to food and body image, which is very common among obese people, binge-eaters and dieters. As an approach that helps with connecting to our own inner wisdom, mindful eating may take time and persistence to provide substantial benefit.

Overall, our results suggest that a mindful eating approach, in addition to its recognized value in the treatment of eating disorders, can be a useful and safe tool in the management of cardiometabolic alterations.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/dietetics3030022/s1. Table S1: Risk of bias in the studies included. Figure S1: Funnel plot of the effect of mindful eating on body weight changes.; Figure S2: Funnel plot of the effect of mindful eating on BMI changes; Figure S3: Funnel plot of the effect of mindful eating on waist circumference changes; Figure S4: Funnel plot of the effect of mindful eating on serum glucose changes; Figure S5: Funnel plot of the effect of mindful eating on glycated hemoglobin changes. Figure S6: Funnel plot of the effect of Mindful Eating on C-Reactive protein changes: (a) 3–4 months. (b) 6 months.

Author Contributions: P.I.I. and P.S. conceived the work. P.I.I. wrote the work. P.I.I. and L.D. selected the articles for the systematic review. L.D. elaborated the meta-analysis. P.S. revised the selection process and the entire manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflicts of interest.

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